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COMPILATION OF INFORMATION RELATED TO WATER QUALITY OF LAKE TAHOE

Carl M. Walter, et al

Public Health Service
San Francisco, California

September 1961

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COMPILATION OF INFORMATION RELATED TO WATER QUALITY OF LAKE TAHOE

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   a. Department of Public Health
   b. Department of Water Resources
   c. State Water Pollution Control Board
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   e. Fish and Game Department
   f. Water Rights Board
   g. Placer County Health Department
   h. El Dorado County Health Department
   i. Lahontan Regional Water Pollution Control Board
   j. South Tahoe Public Utility District
   k. North Tahoe Public Utility District
   l. Tahoe City Public Utility District
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   b. State Engineers Office
   c. Department of Conservation and Natural Resources
   d. Fish and Game Department
3. United States Government
   a. Bureau of Reclamation
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   c. Forest Service

4. Other Agencies

a. Lake Tahoe Area Council

b. Lake Tahoe Regional Planning Commission

c. California-Nevada Interstate Compact Commission.

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SUMMARY

This report is intended to present the most recently available data and information pertaining to water quality in the Lake Tahoe Basin. These data and information are arranged in four sections as follows: economic development, water uses, waste disposal and water quality. Supporting tables and appendices of supplementary information are included.

Evaluation of the data leads to the following conclusions:

1. Presently the quality of water in Lake Tahoe is excellent, usually exceeding the U. S. Public Health Service Drinking Water Standards without treatment;

2. Based on information gathered for this report, the methods of sewage treatment presently used seem to be adequate at this time in protecting the lake from pollution;

3. Accelerating land development and population growth in the Basin are threats to the preservation of the existing quality of water in the lake. Comprehensive and integrated land use planning is essential. Special attention should be given to the future problems associated with the collection, treatment and disposal of sewage and other wastes; and

4. Presently available information is not sufficient for planning purposes. Existing data on future populations, water uses, feasible methods for the treatment and disposal of wastes, and fundamental hydrology and limnology of the lake are too meager to provide a basis for planning and action to protect the water quality in the Lake Tahoe Basin in the future.

The following discussion outlines a few areas where further investigation is needed.

DISCUSSION

Water is the most important natural resource in the Lake Tahoe Basin. The lake is famous as a water sports center and each year many tourists visit the area. Much of the lake's attractiveness can be attributed to the purity of water within the lake. In the Tahoe Basin where the economy is so heavily dependent on the water resource, the proper management of this resource is essential.

At present, the quality of the water in Lake Tahoe is satisfactory for all major uses with little or no treatment. For example, it requires only simple chlorination for use as drinking water. As increased waste volumes are generated in the basin, protection of the quality will become more difficult. This is the important problem and is of immediate concern. Random land development, the numerous public service agencies and conflicts regarding water use contribute to the problem of protecting the quality of the water. Comprehensive and coordinated planning

for land use, water use, waste collection and disposal and other public functions are necessary for protection of the natural values of the Basin, including its excellent water quality.

There are three areas that need more investigation and are important to any consideration of water resource problems in the Basin:

1. What is the pattern of population growth and land use which is developing and how does this conflict with those values that are felt to be desirable?

2. What are the water resource requirements necessary to serve the anticipated development?

3. What is the capacity of the Basin and its environs to meet these requirements and how can this capacity be utilized most effectively?

Roads, houses and paved areas mean surface runoff and storm sewers dumping nutrients and turbidity into the lake. Large numbers of people generate quantities of solid wastes, which have to be disposed of by incineration or sanitary landfills, one a potential air polluter and the other a water polluter if seepage occurs. Homes and business enterprises need sewers, and sewage needs treatment, but when these are provided, final disposal of the effluent still is a problem. Each of these sources of wastes can affect the water quality in the ground, in a stream or in a lake. Yet this same water is needed to drink, to water lawns, to flush toilets or to wash dishes. More specific knowledge of just what might be expected to occur from urbanization depends on what forms of development take place, and from investigation of the pollution that results from different types of land use, e.g., drainage from fertilized lawns adding nutrients to the water, seepage from a sanitary landfill, water use by both visitors and residents or sewage loading created by each user group.

Consideration of the water requirements of all user-groups is necessary. Each type uses water, for drinking, bathing, irrigation, water sports, etc. Specific use figures are not readily available, and land use and population forecasts would have to be used to calculate specific requirements. If sufficient water of good quality is not available, economic development would be limited.

Research on the limnology of Lake Tahoe and on the total hydrologic budget of the Basin can help establish an estimate of capacity. Limnology is important since the lake is presently ultra-oligotrophic and acceleration of the eutrophication process would be undesirable. Hence, the determination of the effects of pollution, whether from storm drains, fertilizer from well-watered lawns, municipal treatment plants, septic tank seepage or leach from a sanitary landfill requires continuing limnological investigation. The hydrologic budget which gives some measure of natural supply and demand must be equated with alterations for human use to determine how much water is available for consumptive and nonconsumptive purposes. Each type of water user has

differing quality requirements, which adds another conditioning factor. Therefore, capacity becomes a function of limnology, hydrology and waste collection, treatment and disposal.

Having outlined some questions for investigation and sketched in some approaches to the solution, the problems affecting water resources are partially defined. Completing these investigations will not give the pat solution. There remains the further necessity of setting objectives. The people of the Basin and their governmental bodies should be provided with complete knowledge of the alternative physical, economic and political requirements necessary for achieving any chosen objectives, i.e., land use controls, water use priorities, expenditures for recreational and community services, and even possible changes in governmental structure.

This is a planning job. Planning should outline what is desirable, as determined by proper investigation and show what sacrifice, whether in water quality or economic development, is necessary to insure adherence to those objectives that represent the desired social benefit. Some compromise if necessary, that is clear, but only careful investigation and planning can show that compromise of land use, water use, waste disposal, etc., which results in the desired combination of water quality and economic development.

INTRODUCTION

The recent expansion of the urbanized area and the subsequent population increase in the Lake Tahoe Basin has caused considerable concern about the quality of the lake waters. The pristine purity of the lake, which is one of the West's most outstanding recreational attractions, may be irreparably damaged if adequate water quality management programs are not initiated. The potential water quality problems have been recognized by both the water pollution control agencies of California and Nevada. The unprecedented speed of development of the Basin has caused a need for immediate action. In view of this, the Public Health Service, the Lahontan Regional Water Pollution Control Board of California, the Nevada State Health Department, and all other state and county agencies charged with water quality activities, held a conference to discuss Lake Tahoe water quality problems. The conclusion of this conference was that a comprehensive study and action program to protect the quality of the Basin's waters should be initiated without delay. The Public Health Service was requested to coordinate a compilation and evaluation of existing information preliminary to further steps toward this goal.

AUTHORITY

Under the terms of Section 4 of Public Law 660, 84th Congress, the Surgeon General is authorized to conduct and cooperate on any investigations relating to the causes, control and prevention of water pollution. Also, under the provisions of Section 8 of Public Law 660, the Surgeon General is authorized to investigate interstate pollution problems. Since Lake Tahoe is an interstate body of water and since assistance from the Public Health Service was requested by appropriate water pollution control agencies, this investigation is authorized by and follows the intent of Public Law 660.

PURPOSE AND SCOPE

The purpose of this report is to present the water quality data that have been collected during this investigation. The scope of the study was limited to a compilation and evaluation of existing data collected from the files of the water pollution control agencies of California and Nevada and from other entities that had data pertaining to the water problems at Lake Tahoe.

PHYSICAL DESCRIPTION

A. Lake Tahoe. Lake Tahoe is situated in the Sierra Nevada Mountains between latitudes 38° 56' - 39° 15' and longitudes 119° 25' - 120° 10'. (Figure 1 shows the Lake Tahoe Truckee River Watershed). The California-Nevada boundary line divides the lake, apportioning about two-thirds of the surface area to California. The lake has a water surface area of approximately 193 sq. miles at an elevation of 6,223 feet (Lake Tahoe datum). Figure 2 shows the Lake Basin. The maximum recorded depth is 1,645 feet, and the average depth 989 feet. The total volume of the lake is 122,000,000 acre-feet.

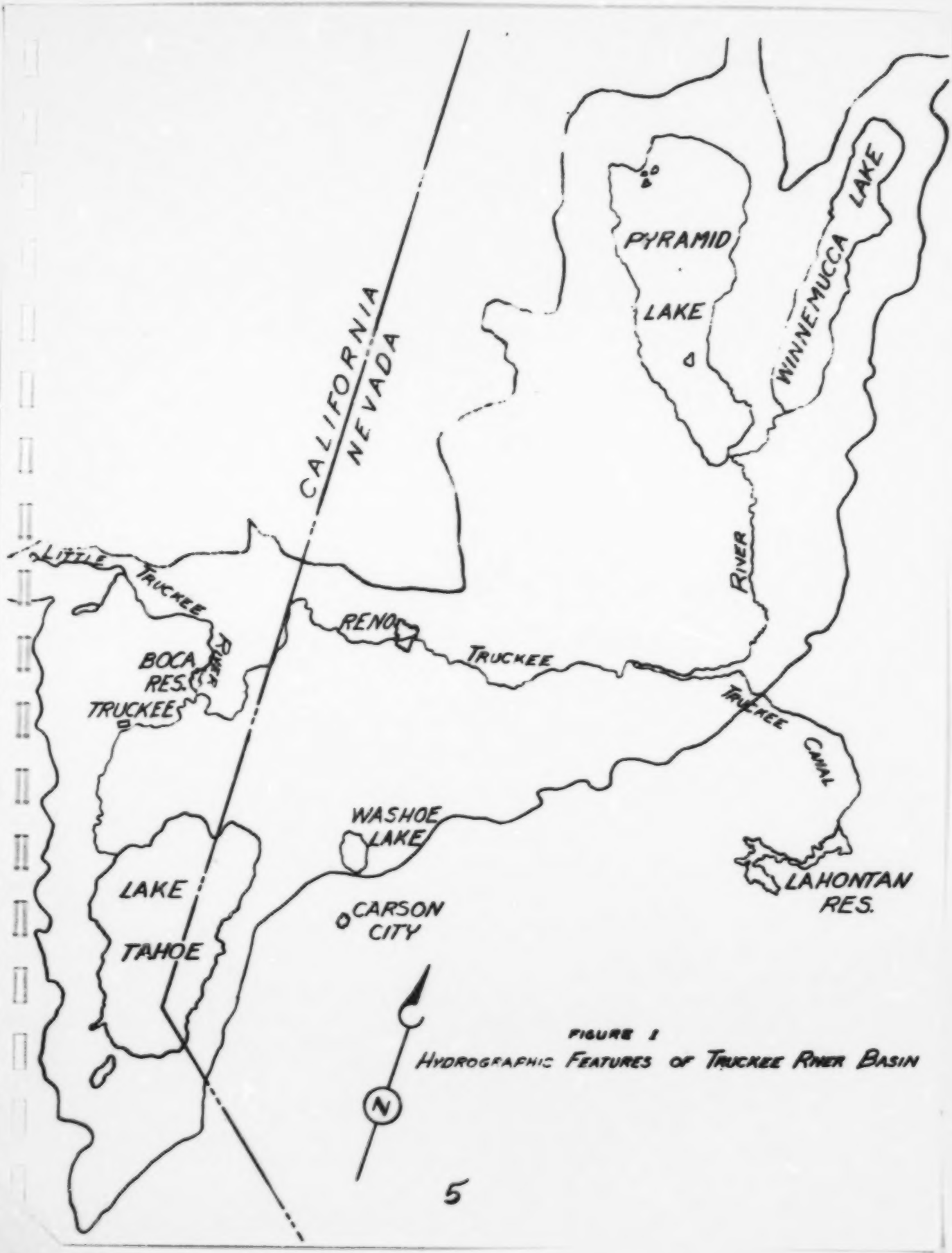

FIGURE 1
HYDROGRAPHIC FEATURES OF TRUCKEE RIVER BASIN

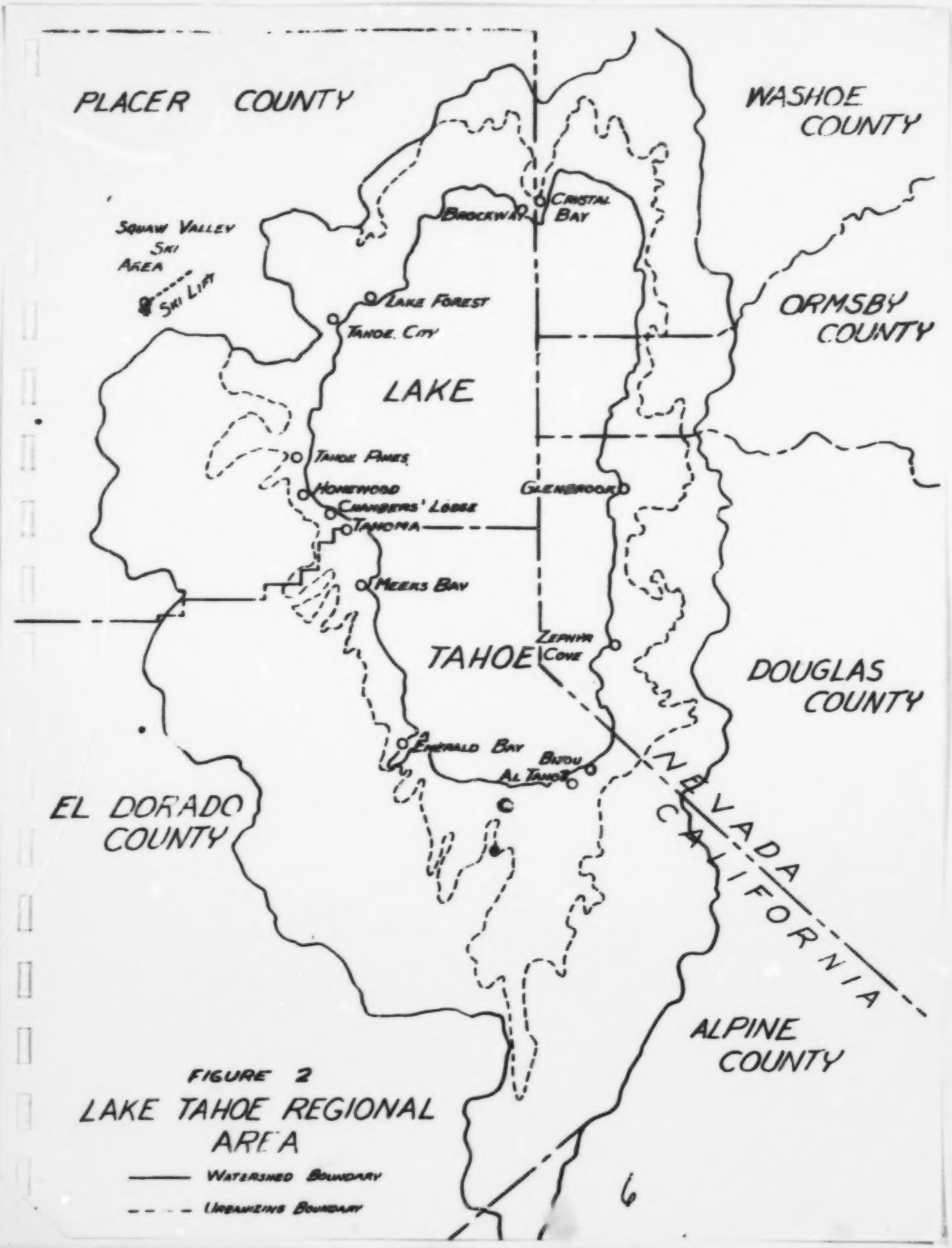

FIGURE 2

LAKE TAHOE REGIONAL AREA

—— WATERSHED BOUNDARY

- - - - URBANIZING BOUNDARY

Tributary inflow is derived from many short mountain streams which carry runoff from the surrounding Carson Range and the Sierra-Nevada Mountains. The lake serves in part as a storage reservoir, using the top six feet (i.e., between surface elevations 6223 and 6229.1) which has a volume of approximately 720,000 acre-feet. Federal regulations prohibit the variation of the lake surface elevation beyond the extremes listed above. The only known outlet, which is controlled by a small dam, is at the head of the Truckee River at the north end of the lake. The Lake Tahoe watershed comprises about 519 square miles. The majority of the lands bordering the lake are privately-owned except for that land which is in the El Dorado, Tahoe and Toiyabe National Forests. A number of private residences and resorts have been built on the adjacent shore land which have transformed the Tahoe Area into one of the West's most popular summer vacation areas. The 1960 Olympic Games, which were held at Squaw Valley, demonstrated that this area is also one of America's foremost winter vacationlands.

B. Water Resources. Lake Tahoe is a natural fault block-type lake with the north end formed by a glacial moraine. Since 1870 an artificial control structure has existed at the north end. This outlet, the only natural exit for the lake waters, is controlled by the Truckee-Carson Irrigation District of Nevada in behalf of the U. S. Government. The Federal Government claims the right to store water between elevations 6229.1 and 6223, and to release from the lake a maximum of 3,000 c.f.s. These rights date to a priority of 1903, and were confirmed in the Truckee River Decree of 1944 in which a Federal court adjudicated the rights of most of the users of Truckee River water. However, neither the State of California nor Nevada nor the adjacent Lake Tahoe property owners are parties to that decree. Nevertheless, past history has shown that the lake has been operated according to the decree and water has been stored in the lake for the downstream users.

As stated earlier, the permissible lake level fluctuation of six feet allows for a storage of 720,000 acre-feet. In 1951, when the lake level reached 6228.9 feet - 0.2 of foot below maximum - over $200,000 damage occurred to the lake shoreline and adjacent structures. Lowering the lake to the minimum level of 6223 feet would cause extreme difficulty with docking facilities in the shallow areas.

Last but not least, one of the greatest users of Lake Tahoe water is nature. Natural evaporation accounts for some 23 inches (i.e., about 250,000 acre-feet) during the summer months. Consequently, it can be seen that the useable water volume is much in demand. At the present time the water rights of all of the downstream users have not been analyzed, but it is believed that they are considerably in excess of the available supply as the lake is presently regulated. There are also many water rights existing within the Basin, not all of which have been adjudicated. Several alternatives have been proposed to alleviate the water shortage. In a joint report by the Bureau of Reclamation and the Corps of Engineers the following were suggested:

1. Water storage at other sites to allow lowering of the lake level.

2. Cutting the outlet rim of the lake, and lowering the upper and lower water surface limits about one foot.

3. Salvaging water by reducing downstream and canal losses, thus permitting a reduction of Tahoe storage by an equal amount.

4. Purchasing and abandoning of certain water rights to use Tahoe water.

5. Any combination of two or more of the above.

Table 1 shows the water budget for the Lake Basin.

C. Waste Disposal Problems. One of the basic requirements of any sewerage system is the provision of a safe, innocuous method of effluent disposal. In the Lake Tahoe Basin, essentially four alternatives exist. These are: (1) discharge to the lake or its tributaries; (2) removal from the Lake Basin; (3) deep well injection; and (4) spreading on land. There are, however, strenuous objections to any of the proposed alternatives.

1. Discharge to the lake or its tributaries. Nevada Revised Statute 445.090 specifically prohibits the discharge of sewage or other wastes into Lake Tahoe or into any stream reservoir, spring, well or other water supply in the Lake Tahoe Basin. In California, Resolution 52-3 adopted by the Lahonton Regional Water Pollution Control Board states that sewage or industrial wastes, which does not meet Public Health Service Drinking Water Standards at all times, shall not be discharged into the surface waters of the Lake Tahoe and Truckee River Watersheds. A re-appraisal of Resolution 52-3 by the Lahonton Board was made in 1958, and Resolution 58-1 was adopted to further substantiate the intentions of the Board to protect the quality of Lake Tahoe and tributary surface waters. In addition, both California counties have specific ordinances prohibiting the discharge of sewage into surface waters.

2. Removal from the Lake Basin. The problem of removal of sewage effluent from the Lake Tahoe Basin is extremely complex. Complications arise due to the interstate nature of the Basin and the methods of water right allocation both within and outside the Basin. Ultimate disposal of effluent outside the Basin can be achieved if an adequate legal system is established to determine the net effects of effluent exportation on the water allocations both within and outside the Basin.

3. Deep well injection. This proposal was eliminated because of the possibility of eventual contamination of the lake through the ground water.

4. Spreading on land. At the present time, land disposal is the only method used for disposing of sewage within the Basin. There are three utility districts within the Basin. These districts, Tahoe City Public Utility District, North Tahoe Public Utility District and South Tahoe Public Utility District, are utilizing either

TABLE 1

LAKE TAHOE AND TRUCKEE RIVER BASINS
AVERAGE ANNUAL WATER SUPPLY AND WATER USE

Quantities in acre-feet except as noted

Area of Basin in acres			280,000
Average Precipitation in inches			27
Volume of Precipitation			630,000
Evapo-transpiration Losses			
Lake Evaporation	124,000 x 27 ÷ 12 = 275,000		
Watershed Vegetation	160,000 x 16 ÷ 12 = 215,000		
Total			490,000
NET NATURAL WATER SUPPLY			140,000
USE OF WATER FROM LAKE TAHOE BASIN AS OF 1956			
Consumptive Use within Basin		6,000	
Marlette Lake Diversion		3,000	
Echo Lake Diversion		2,000	
Total			11,000
DISCHARGE TO TRUCKEE RIVER			129,000
Natural Inflow to Truckee Below Lake Tahoe			406,000
Subtotal			535,000
USE OF WATER FROM TRUCKEE RIVER BASIN AS OF 1956			
Consumptive Use in California		3,000	
Sierra Valley Diversion		14,000	
Subtotal		17,000	
Consumptive Use in Nevada		151,000	
Diversion to Newlands Project (TCID)		257,000	
Total			425,000
INFLOW TO PYRAMID LAKE			110,000

evaporation-percolation ponds or a combination of ponds and a spray irrigation system to dispose of sewage effluent. Private homes and other developments outside the boundaries of the utility districts rely on septic tanks for sewage disposal.

Several problems arise from the use of land disposal methods. There is major concern over the possibility of contamination of the ground water and eventually of the lake. The geological characteristics of the Basin are such that much of the existing soil profile is not suitable for adequate waste disposal. Finally, there is considerable competition for the available land within the Basin which could make land disposal extremely costly.

ECONOMIC DEVELOPMENT

The scenic and recreational qualities of the Lake Tahoe Basin and its surrounding wooded areas and mountains are dominant reasons for the development of the Lake Tahoe Basin. The area offers year around recreational opportunities, a pleasant climate for habitation, and legalized gambling in Nevada.

These several attributes, coupled with the availability of land, have been developed into an agglomeration of small communities, residential subdivisions, commercial areas and improved recreational areas.

Heaviest development, in terms of numbers of people and density of land use, is at the south end of the lake where the two states meet. This area includes the communities of Stateline, Bijou Park, Bijou, Al Tahoe and Tahoe Valley and has a population of approximately 7,000 residents in 1960.

A similar, though less populous, area of development exists at the north end of the lake at the boundary between the two states. The communities of Tahoe City, Tahoe Vista, Brockway and Kings Beach have a 1960 population of approximately 3,000 people.

Scattered around the lake between these two more populous sections are numerous clusters of residences and commercial enterprises of various kinds and sizes. Many of these places are occupied only during the summer months. None of the lake communities are incorporated, but the south end is presently considering incorporation under the California State laws.

In 1960 there were an estimated 8,000 motel units on the south shore, with 1,000 new units being added yearly. There were also 6,000 units on north and west shores, for a total of over 14,000 units.

Improved recreational areas of several types have been developed. Squaw Valley and Heavenly Valley along with many smaller areas scattered along the surrounding mountains provide skiing opportunity in the winter months. Summertime outdoor recreation is focused on the lake with fishing, swimming, water skiing being popular. County and state parks provide camping facilities and limited access to the lake. Gambling casinos on the Nevada side provide another type of recreation.

The growth of population has been accompanied by a growth in government services and a number of public and semi-public special function groups. The lake is bordered by five counties, El Dorado and Placer Counties in California, and Douglas, Ormsby and Washoe Counties in Nevada. Each of these counties provide some services, usually in conjunction with the respective state. These agencies typically provide roads and health and welfare services. Water and sewerage problems have been handled on a more local basis with water being supplied by a number of public and semi-public groups. The sewage problems have usually been handled by individual action or special function groups, like the water problem with three public utility districts, the Tahoe City Public Utility District, the North Tahoe Public Utility District, and the South Tahoe Public Utility District having been formed. The many residential and commercial developments outside the districts utilize individual septic tanks.

To get an effective government system and the services and controls necessary to insure maximum benefits to the public as a whole, rather than short-run gains to individuals, requires adequate planning and a fairly stable economy. The importance of the economic development is that it forms the base on which a government system develops, as the role of government is primarily as a service organization for the public. Hence, some analyses of the factors in the economic development of the Lake Tahoe area and how this growth relates to water supply and water pollution would seem in order.

The anticipated water pollution problems in the Lake Tahoe area may be attributed to the land use patterns that are developing. Human use of an area typically requires occupancy of the land and the building of facilities on this land. Consequently, sewers, land erosion, roads, houses and the other features of man's use of the environment are impressed on the topography by the resulting land use patterns.

These land use patterns determine the probable populations in the Basin, and hence, are a guide to a forecast of potential pollution problems. Logically there are many ways that land use may be classified, but one way in particular seems to be adaptable to the forecasting process. This classification would see the population as the result of three using groups, differing by their time of stay in the area, as follows:

1) permanent residents - people employed in the area and their families;

2) part-time residents - principally occupants of seasonal homes, also retired persons; and

3) temporary visitors - tourists, highway travelers and others whose length of visit in the area is limited, and who are nonowners of the facilities they use during their stay.

Based on this time classification a rational approach to a prediction of future populations and land uses can be developed by

considering the determinants of the growth in each of the user-groups. This development can be presented by discussing each group and its interrelations with the other groups, explaining growth factors in each class and the land use requirements to satisfy this growth, finally attempting to show how these land requirements are equated and the way this determines population growth and density.

A. Permanent Residents

The permanent residents, as defined, consist of those people employed in the area and their immediate families. Employment opportunities are important in determining the size of this group. Growth of employment in this area might be considered to have two components, the first component being manufacturing industries, the second component being trades and services. This definition can't be made precise but but a distinction in growth potential is clear.

Manufacturing industries can be tied to their location factors, with three possible classifications: raw material oriented, market oriented and footloose industries. The potential of each of these can be considered separately.

a. Raw material oriented industry in the Lake Tahoe Basin would be geared to lumbering, mining and agriculture. There appears to be little growth potential for these industries, except agriculture, which may increase in areas outside the Basin and enhance the economic growth potential in the other industries by providing a larger market for locally manufactured products, trades and services.

b. Market oriented industry is tied to the size of the local market, with transportation and scale of manufacturing as modifying factors. In this category boat-building, sheet-metal fabrication and other light manufacturing may be a possibility.

c. Foot-loose industries have no specific location requirements, but tend to equate good climate and other amenities that people enjoy as important features of the location. The Lake Tahoe area offers many of the amenities that people favor and might attract some foot-loose industries.

Forecasting the growth potential of the manufacturing industries is difficult without some knowledge of what people want and what effect or consequences will result from planning, regulations and peoples' behavior, but a reasonable estimate would place total direct manufacturing employment in the future at less than 10% of the total employment.

Trades and services can be expected to grow with the total growth in user-group populations. Temporary visitors need motels, meals, gasoline, etc. Part time residents and permanent residents will want food, water, sewers, clothing, maintenance services, etc. All these groups interact to cause a variety of commercial stores, shops, restaurants and service companies to form to meet their demand.

The limiting factors on local employment are the self-sufficiency of the area and the income that is brought in from outside the area by part-time residents and temporary visitors. The Lake Tahoe Basin isn't self-sufficient, i.e., it can't provide all the food, clothing and other manufactured articles that it needs from within its border. Therefore, employment tends to be limited by the income that is derived from outside the area. This derived income is a function of the demand for goods and services in the local area by the part-time residents and the temporary visitors.

Hence, to get some idea of what the permanent population will be, the limiting factors on the numbers of part-time residents and temporary visitors must be considered.

B. Part-time Residents

Part-time residents were defined as occupants of seasonal homes or retired persons. The reason for defining a retired person as a part-time resident is that his reasons for living in the area are the same as the part-time resident; also, he demands the same types of goods and services as the part-time resident.

The population of part-time residents will be limited principally by the land available for seasonal homes. Land exists as a limited resource, hence, zoning laws, topography and other restrictions will limit the density of development. The present restrictions, which include a limitation on credit for lending on seasonal homes (mortgages are commonly limited to eight years and interest exceeds 7%), may have hindered growth some, but there is ample evidence of the demand for housing, both for seasonal and permanent use.

There are about 115 square miles of land in the Basin with slopes of less than 25% which can be considered as potential building area. (See Table 2.) Some of this land is already used for commercial properties, parks, etc. Assuming that 75 square miles may be available for seasonal homes and projecting a population of 1,000 people per square mile maximum (as might occur over a summer holiday such as the Fourth of July), a peak population of 75,000 part-time residents is possible.

When such a population will occur will, of course, depend on the growth trends in second homes, which again is a function of the restrictive variables such as credit, availability of land, zoning and people's desire for second homes.

C. Temporary Visitors.

Temporary visitors may come for a variety of reasons. Some may be passing through enroute to another destination and stopping only to enjoy a few of the facilities. The other portion may be in the area specifically to enjoy the recreational opportunities such as skiing, fishing, water sports, gambling or sight-seeing.

The potential number of visitors is a function of the general characteristics of the population user groups: the total population,

TABLE 2

Land Area by County and Type of Land

County	Total Watershed Land Sq.Mi.	%	Watershed Over 25% Slope Sq.Mi.	%	Urban Area Under 25% Slope Sq.Mi.	%	Lake Sq.Mi.	%	Shoreline Mi.	%
Placer	63	20%	26	13%	37	32%	79	41%	19.5	29%
El Dorado	172	56%	121	63%	50	44%	55	29%	20.5	31%
Washoe	29	9%	22	11%	8	7%	22	11%	11.0	16%
Ormsby	9	3%	6	3%	3	2%	12	6%	4.2	6%
Douglas	36	12%	19	10%	17	15%	25	13%	11.8	18%
	309		194		115		193		67.0 lin. mi.	

their income levels, their mobility, the amount of time they can spend on leisure and their tastes or preferences for the types of recreational opportunities offered by the Lake Tahoe area. Their visits are also a function of what is available in the area and its accessibility, as compared with alternative recreational opportunities.

A good forecast of temporary visitors to the area would consider the types of recreational opportunities wanted by the visitors and the availability of these opportunities and then equate these to access and socio-economic factors. Recognizing these factors and assuming that sufficient recreational facilities would be available to meet the demand, an estimate of 150,000 people per day appears to be a reasonable approximation of maximum use by the temporary visitor group in the next 20 years.

D. Synthesis

A much better forecast of the populations and land use patterns could be made if the necessary data were available. Planning objectives and probable governmental regulatory actions, which both act as restraints on development, are in the early stages of formulation. Leisure time, income and mobility factors for the potential tributary populations will greatly affect the numbers of part-time resident and temporary visitor user groups. Industrial potential, especially in terms of attractiveness to foot-loose industries, is significant in terms of permanent residents. In summary, the development of the Basin will be dependent on the initiation, implementation and administration of a comprehensive plan by those agencies representing the people with interests in the Basin. Appendix D contains additional information on the future development in the Basin.

Based on the preceding discussion, a reasonable estimation of the potential population within the next 20 to 30 years in the Basin would be as follows:

Peak temporary visitors		150,000
Part-time residents		75,000
Permanent residents based on a ratio of 1 permanent resident to 10 of the other user groups		25,000
	Total	250,000

Some population data for 1960 are presented in Table 3, sections I and II. A comparative population forecast is presented in section III, Table 3. This forecast tends to be more optimistic than the forecast in the preceding paragraph and is a good indication of the range of possibilities. Sections IV, V and VI of Table 3 give some specific forecasts for areas within the Basin.

TABLE 3

POPULATIONS AND POPULATION ESTIMATES

Population Estimates from Other Sources

I. U. S. Bureau of Census - 1960

El Dorado Co. - Lake Valley Division	7,897
Placer Co. - Lake Tahoe Division	3,248
Douglas Co. - Tahoe Division	1,017

Data for Ormsby and Washoe Counties not separable from Total County figures.

II. California Roster - State of California - 1960

Estimated 1959 populations of unincorporated areas in California.

Al Tahoe	531
Bijou	1,400
Brockway	125
Lake Tahoe	400
Meeks Bay	65
Meyers	60
Tahoe City	200
Tahoe Vista	200
Total	2,681

TABLE 3 (Continued)

III. Population estimates for Lake Tahoe area from the paper "For a Greater Lake Tahoe," by Raymond M. Smith, presented at the PSIAC meeting June 16-18, 1960, in Carson City, Nevada.

Year	Optimum Summer Population	Optimum Winter Population
1960	80,000	18,000
1970	180,000	40,000
1980	335,000	76,000
1985	426,000	99,000

IV. Population estimates for Douglas County - by Raymond M. Smith, from a report by George S. Holte, consulting civil engineers, titled "Feasibility of Formation of a General Improvement District to Serve the Tahoe Basin Area of Douglas County - 1959."

Year	Population
1960	18,500
1975	33,500
1990	38,500
2010	44,300

V. A maximum population of 26,500 is forecast for Incline Village, Washoe County, a project of the Crystal Bay Development Company. This forecast is from "Incline Village - Preliminary Report on Water Supply and Sanitary Sewerage Systems," by International Engineering Co., July 1960.

TABLE 3 (Continued)

VI. Population estimates for the South Tahoe area (El Dorado and Douglas Counties) (by Brown and Caldwell, consulting engineers, found in the report "South Tahoe Sewerage Survey - 1959," prepared for South Tahoe Public Utility District.

Year	Population Estimate		
	High	Low	Average
1958	60,000		60,000
1960	75,000	68,000	71,000
1970	151,000	108,000	121,000
1980	209,000	130,000	161,000
1990	260,000	145,000	191,000
2000	300,000	159,000	216,000
2010	316,000	161,000	243,000

WATER USES

Data on water uses within the Lake Tahoe Basin were collected from the California State Water Rights Board and from the Nevada State Engineer. Both states differ somewhat in the water rights acknowledged. The State of California, at the present time, recognizes appropriated rights as delineated by the Water Rights Board, riparian rights, and land owners rights to subsurface waters underlying the property. In the State of Nevada, only appropriated rights as delineated in the files of the Office of the State Engineer are recognized.

For the State of California some deficiencies of the available data exist in that many of the riparian rights and property owner's rights to underlying groundwater have not been recorded. Furthermore, many of the water rights dating prior to 1914, which is the date of the establishment of the water rights legislation, are also not recorded. Nevada recognizes two classes of appropriative water rights: these are the vested rights initiated in the early days of the State's development and the appropriative rights acquired after March 1, 1905, which are provided for in the Water Law of Nevada.

Table 4 summarizes the available data on the number on water rights applications in both states. Table 5 presents a breakdown of the water rights applications according to water use. The total appropriated waters for the Tahoe Basin as listed are divided as follows: the approximate yearly usage of water in California is 48,000 acre feet and in Nevada is 104,000 acre feet.

The data on water rights for the waters of Lake Tahoe show there are 14 appropriation applications in California. Only one of these is under license and one other is under permit. The remaining applications are classified as pending. The total quantity of appropriated water from the California side of the lake is approximately 12,900 acre feet.

A similar summary of water rights for water from Lake Tahoe for the Nevada side of the lake shows 37 appropriation applications under certificate and 25 water appropriation applications under permit. The total yearly amount appropriated from Lake Tahoe Nevada is approximately 17,300 acre feet.

Supplementary data on water use are available from the health agencies responsible for monitoring the quality of water supplied by domestic purveyors. Information on the water systems in the Lake Tahoe Basin was collected, but it is not included separately in this presentation since it is summarized in Tables 4 and 5. However, it is mentioned here because the specific data are available.

Some mention should be made of the water uses and requirements of the Federal Government. The U. S. Forest Service uses water to maintain the forests, the camp grounds and for fire protection. These uses are included in the water rights summary. In addition, as mentioned earlier, the Federal Government has rights, which it exerts through its agent, the Truckee Carson Irrigation District, to the top 6.1 feet of storage in the lake. This amounts to approximately 720,000 acre feet.

TABLE 4

WATER RIGHTS IN THE LAKE TAHOE BASIN

Total Number of Water Rights on Record in

CALIFORNIA

License	49
Permit	22
Pending	25
Other 1/	8
TOTAL	104

NEVADA

Certificate	88
Permit	34
Proof	3
Civil Court Decree	7
Other 1/	2
TOTAL	134

1/ Other includes files of water use on record whose status was indeterminable from the information presented or whose status was different from those mentioned previously.

TABLE 5

WATER USES IN THE LAKE TAHOE BASIN

Division of Water Rights on Record Based on Use 1/

USE	CALIFORNIA	NEVADA	TOTAL
Domestic	90	135	225
Municipal	33	62	95
Recreation	19	17	36
Irrigation	2	48	50
Stockwatering	--	12	12
Power	2	5	7
Mining	1	--	1

1/ Values stated represent the number of appearances of these water uses in the water appropriation records, and therefore, any multipurpose water right application would appear more than once in the above listing depending on the multiplicity of use.

Other agencies, downstream property owners and the Pyramid Lake Indians have rights to the use of the Truckee River of which Lake Tahoe is a principal source. These water rights directly affect the demands on Lake Tahoe.

At the present time the States of California and Nevada are negotiating an interstate compact to govern the use of water in the Lake Tahoe, Truckee River, Carson River and Walker River Basins. The proposed compact terms relating to the water resources of the Lake Tahoe Basin are shown below.

These negotiations are an outgrowth of the problems faced by the water right administrators of California and Nevada in the late 1940's. On the Truckee River System the principal water using agencies in Nevada, including the Sierra Pacific Power Company and the Truckee-Carson Irrigation District, consistently protested all new water right applications on the basis that there was no unappropriated water available from natural flow in excess of adjudicated and/or claimed rights to the use of water from Lake Tahoe and the Truckee River. Their position is supported by operation studies of Lake Tahoe which indicate that there was a period of about 15 years during the period 1923 through 1937 during which there was no spill from Lake Tahoe which was not diverted and used. However, water right administrators have continued to issue permits for appropriation pursuant to a finding in 1949 by the State Engineers of California and Nevada that domestic water use in the Lake Tahoe Basin would not damage the Truckee River water users.

Proposed Compact Terms

The provisions of the draft of proposed compact terms, dated February 15, 1961, applicable to the Lake Tahoe Basin are contained in Articles II and VIII.

Article II - Section 1 (Alt) is the definition of the Lake Tahoe Basin boundary. A compromise between the hydrologic and economic boundaries of the area was made by extending the boundary of the Basin to a point on the Truckee River about 1¼ miles downstream from the outlet of the lake.

Article VIII - Section 4 will permit the use of 34,000 acre-feet of water annually within the Lake Tahoe Basin. This quantity of water is estimated to be sufficient to supply the municipal water requirements for an average July-August population of 434,000 persons or 60 million visitor days per year, and for 2,400 acres of agricultural land, golf courses and parks. The geographical distribution of the population on private lands is shown on a land use and classification map prepared by the California Department of Water Resources for the commission.

There is also provision for use of water in excess of the 34,000 acre-feet if the commission finds that changes in land use result in increased runoff which would offset the consumptive use by an amount sufficient to prevent the increased depletion of water supply available to the Truckee River water users from exceeding 7,500 acre-feet per annum more than depletion as of the date of the compact.

Article VIII - Section 7 would require that the water quality of Lake Tahoe and tributaries be maintained at quality levels suitable for fisheries, recreational use, and domestic water supply without treatment of

any kind except simple chlorination. Direct discharge of domestic sewage or sewage plant effluents in the Lake Tahoe or tributary streams is prohibited unless the commission finds that such direct discharge would not impair the quality of the lake for the uses specified in the compact. Each state is assigned the primary obligation to take appropriate preventive or corrective action under its own laws to maintain the water quality of Lake Tahoe and tributaries.

Article VIII - Section 8 provides that the commission may permit the export of waste water from the Basin when necessary for the protection of public health and welfare and the quality of the waters of Lake Tahoe Basin. However, this section also requires that, if the export of waste water deprives the Truckee River water users of waters which they would otherwise receive and beneficially use, the commission shall condition the exportation upon either (1) the providing of exchange or replacement waters, or (2) the reduction of the 34,000 acre-foot allocation of water for use within the Basin, or (3) such other terms or conditions as may be necessary to assure that the export of waste water does not result in depriving downstream areas of water which they would otherwise beneficially use.

In summation, an interstate compact which will restrict the use of the limited water supplies of the Lake Tahoe Basin is now being formulated. If ratified by the legislatures of the two states and consented to by Congress, the compact will have the effect of (1) limiting water use within the Lake Tahoe Basin to 34,000 acre-feet per year, (2) requiring that the waters of Lake Tahoe be maintained to specific water quality standards, (3) permitting the export of sewage from the Lake Tahoe Basin provided that the export of sewage does not interfere with downstream water use. These restrictions will be binding on all water users and sewage disposal agencies unless either the compact is superseded by another compact or terminated with the consent of the two states.

WASTE DISPOSAL

In 1915 the California State Board of Health adopted a resolution forbidding the direct discharge of sewage into Lake Tahoe. This policy was the first formal action with regard to waste disposal in the Tahoe Basin. At the present time the waste disposal practices are watched closely by the Lahontan Regional Water Pollution Control Board. This Board, created by the Water Pollution Control Act of 1949, has the authority to specify discharge requirements on any waste discharge within its region. With respect to the Lake Tahoe area, the Board adopted Resolution 52-3 in 1952 which prescribes the following requirements for any waste discharges within the Lake Tahoe and Truckee River Watersheds:

a) "That it is the objective and policy of the Lahontan Regional Water Pollution Control Board to maintain the waters of the Lake Tahoe and Truckee River Watersheds of a quality satisfactory for beneficial uses in the following order of significance:

1. Domestic
2. Swimming
3. Boating
4. Fishing
5. Irrigation"

b) "That the following conditions shall be maintained in all the surface waters of the Lake Tahoe and Truckee River Watersheds:

1. No sewage or industrial waste shall be discharged into the surface waters of the Lake Tahoe and Truckee River Watersheds that does not meet the U. S. Public Health Service Standards for Drinking Water at all times.

2. The dissolved oxygen content of these waters shall not be less than 5.0 ppm.

3. There shall be no floating materials or solids in these waters attributable to sewage or industrial waste origin.

4. The sewage or industrial waste discharges will not create odors or coloration of the waters."

In 1958, the Lahontan Board adopted a second resolution reappraising Resolution 52-3. This new Resolution, 58-1, further substantiated the Board's policy pertaining to waste discharges in the Lake Tahoe and Truckee River Watersheds. The resolution specifically prescribed the following requirements:

a) "That it is the objective and policy of the Lahontan Regional Water Pollution Control Board to maintain the waters of the Lake Tahoe-Truckee River Watershed of a quality satisfactory for the beneficial uses and aesthetic values in the following order of significance:

1. Domestic
2. Water Contact Sports
3. Fishing
4. Boating
5. Irrigation
6. Industrial
7. Power Generation"

b) "That all the domestic and industrial waste discharges into the Lake Tahoe-Truckee River Watershed must be reviewed by the Board, in cooperation with all interested state and local agencies, and requirements established to protect these beneficial uses."

c) "That the Board, in establishing requirements on waste discharges (domestic and industrial), will take full cognizance of all ordinances, rules and regulations of the local, state and governmental agencies, pertaining to the disposal of waste."

Section "c" of Resolution 58-1 is especially significant, since it is the policy of the Placer County Health Department in approving any sewage works to make every effort to keep the sewage effluent on land. In El Dorado County, Ordinances 234 and 259 prohibit the discharge of domestic sewage into the surface waters of the county. Under the California Water Pollution Control Act, Section 13001 states that the rulings of the State and Regional Boards shall not limit the power of

any city or county to enforce additional regulations or restrictions with respect to the disposal of sewage or industrial waste. Consequently, the county ordinances, which are more stringent in this case, are the controlling regulations. In addition, the Regional Board, under the terms of Section 13054.3 of the Water Pollution Control Act, can specify certain conditions and locations where no direct discharge of sewage or industrial waste will be permitted.

In Nevada, the waste disposal problem has been relatively less difficult to handle. The majority of land within the Lake Tahoe Basin is owned by a small number of people. It has, in the past, been the policy of Nevada to restrict direct discharges. In 1957, specific legislation governing waste disposal practices in the Tahoe Basin was enacted. Section 445.090 of the Nevada Water Pollution Control Regulations is quoted below:

"445.090 Discharge of Wastes prohibited; issuance of permit subject to installation of sewage works.

1. Except as provided in subsection 2, the direct discharge of sewage or other wastes into Lake Tahoe, or within 100 feet of the established high water rim of Lake Tahoe, or within 100 feet of a stream, reservoir, spring well, or other water supply in the Lake Tahoe Watershed is prohibited.

2. Where disposal of sewage or other waste by reason of property characteristics, topography or other limitations cannot be provided other than within 100 feet of Lake Tahoe, then the State Department of Health shall issue the required permit subject to installation and operation of sewage works, as may be necessary, to provide protection to the Lake Tahoe water and the Lake Tahoe Watershed."

At the present time, there are three community sewerage systems in the Lake Tahoe Basin. Prior to the establishment of these collection systems and treatment plants, the sewage disposal facilities in these areas consisted of individual systems, such as septic tanks, utilizing some form of land disposal. Rapid development of high density urban areas antiquated the individual systems and brought about the development of these community collection, treatment and disposal facilities. However, many of the residences are, at present, outside of the sewered areas and still depend upon individual disposal systems.

The three treatment plants are located on the California side of the lake. However, two of these plants service the commercialized areas of Nevada near the stateline at both the north and south ends of the lake. Since the urban development of the Nevada portion of the Lake Basin has been somewhat slower than that occurring in California, there have been no sewage treatment plants constructed on the Nevada side. At the present time, a large subdivision in the Incline Valley on the east side of the lake is being developed. Included in the plans is a sewage treatment system. The effluent from this plant will probably be injected into the ground.

The existing community sewage treatment plants are as follows:

1. South Tahoe Public Utility District.

The South Tahoe Public Utility District was formed in 1951. During the period between 1951 and 1958, the District suffered from many difficulties, including legal problems in construction of facilities and operational problems once the facilities were completed. In 1958 an engineering study of the District's waste disposal problems was initiated, and in 1959, based on the results of this study and assisted by a Public Law 660 Grant, a new treatment plant was built. This plant, completed in November 1960, is a modern secondary treatment plant with an activated sludge process. At the present time, the District services the urbanized area in the vicinity of California-Nevada boundary at the south end of the lake. The communities included are Stateline, Bijou, Al Tahoe, Tahoe Valley and Meyers. Effluent from the plant is discharged into an 80,000,000 gallon evaporation-percolation-holding pond and then to a spray irrigation field. The pond and spray system are on U.S. Forest Service land for which the District has a five-year lease. When this lease expires on May 17, 1966, the District will have to find a new method of effluent disposal. Table 6 shows recent operational data for this plant.

2. North Tahoe Public Utility District.

The North Tahoe Public Utility District was formed in 1948. Construction of its collection and treatment system was completed in 1951. Since 1952 the District has occasionally experienced some operational difficulties resulting in the discharge of raw sewage to Lake Tahoe at various times. At the present time, most of the problems have been overcome and except for an occasional odor complaint, little difficulty is being experienced. The North Tahoe plant furnishes primary treatment with ultimate disposal in lagoons located a considerable distance from the plant in the surrounding mountains. The District service area includes portions of Brockway, Kings Beach and the commercialized area of Nevada at the north end of the lake. At the present time, the District is installing a laboratory so that the plant operations can be more closely monitored.

3. Tahoe City Public Utility District.

The Tahoe City Public Utility District was originally formed as a water district. In 1953 the District built a sewage collection and treatment system. The District service area includes only Tahoe City, which is on the west side of the lake at the Truckee River Outlet. The District has a secondary treatment plant including trickling filters. The final effluent is discharged into ponds and through a spray irrigation system. The District has had some operational difficulties in the past and on several occasions raw sewage has overflowed into the Truckee River. At the present time, the District is expanding and improving both the collection system and treatment plant. The District has no laboratory and no operational data were available.

Table 7 summarizes the available data on the three treatment plants.

TABLE 6

SOUTH TAHOE PUBLIC UTILITY DISTRICT

Treatment Plant Efficiency Reports

PROPERTY	UNITS	Month-Year February-1961	Month-Year March-1961
TOTAL FLOW	Gal	16,588,000	24,825,000
DAILY AVERAGE FLOW	Gal	556,000	800,800
CHLORINE (Cl_2)			
Average Residual	PPM	1.1	0.7
SUSPENDED SOLIDS			
of Primary Influent	PPM	278	344
of Final Effluent	PPM	16	22
TOTAL SOLIDS			
of Primary Influent	PPM	916	838
of Final Effluent	PPM	217	138
FIXED SOLIDS			
of Primary Influent	PPM	48	76
of Final Effluent	PPM	7	5
AVERAGE SETTLEABLE SOLIDS			
of Primary Influent (by Imhoff Cone)	ML/L	11.0	19
of Final Effluent (by Imhoff Cone)	ML/L	0.000	0.00034
AVERAGE VOLATILE SOLIDS			
of Primary Influent	PPM	230	268
of Final Effluent	PPM	9	17
AVERAGE DISSOLVED SOLIDS			
of Primary Influent	PPM	638	496
of Final Effluent	PPM	200	116
AVERAGE PER CENT REMOVAL			
of Suspended Solids Through Entire Plant	%	94.2	93.6
of Settleable Solids Through Primary Clarifier	%	99.5	99.1
AVERAGE DISSOLVED OXYGEN			
of Primary Influent	PPM	0	
of Final Effluent	PPM		2.7
AVERAGE BIOCHEMICAL OXYGEN DEMAND			
of Plant Influent	PPM	.243	146
of Final Effluent	PPM-% Removed	17-93	3-91

TABLE 7

SEWAGE TREATMENT FACILITIES IN TAHOE BASIN

NAME	ESTIMATED POPULATION SERVED	ESTIMATED FLOW MGD	TREATMENT FACILITIES AND METHOD OF DISPOSAL
South Tahoe Public Utility District	12,000	0.8	Pre-chlorination, barminutor, pre-aeration, primary sedimentation, activated sludge, secondary sedimentation, post chlorination, land disposal, separate sludge digestion and drying beds.
North Tahoe Public Utility District	5,000	0.5	Aeration, primary sedimentation, ponds and land disposal, separate sludge digestion and drying beds.
Tahoe City Public Utility District	1,400	0.2	Bar screen, primary sedimentation, trickling filter, secondary sedimentation, land disposal, separate sludge digestion and drying beds.

WATER QUALITY

In April 1951, the California State Department of Water Resources established, at the request of the State Water Pollution Control Board, a statewide surface water sampling program. As a result of this program, three water quality monitoring stations were located at Lake Tahoe as follows:

1) on a pier 0.1 miles west of Tahoe Vista and 8 miles northeast of Tahoe City;

2) at Tahoe City upstream from the control gates of the Truckee River; and

3) at Connolley's Pier at Bijou.

Monthly samples have been collected from each of these stations and, except for the May and September samples, are subjected to a partial mineral analysis. The samples collected in May and September which represent the extreme flow conditions, are subjected to a complete mineral analysis. Tables 8 through 10 present a summary of the water quality analyses performed by the State.

Except for an occasional high turbidity the lake water quality far exceeds the 1961 U. S. Public Health Service Drinking Water Standards which are shown in Table 11.

Table 12 summarizes the bacteriological and dissolved oxygen results as reported by the State. Samples for these analyses were taken at the same three monitoring stations listed above. In general the coliform MPN of the bacteriological samples has been well below the permissible monthly average of 50 per 100 ml. for drinking waters receiving only simple chlorination as suggested in the Public Health Service Manual of Recommended Water Sanitation Practice (1946). The dissolved oxygen concentrations further demonstrate the high quality of the Lake Tahoe waters. It has also been reported by the Nevada State Fish and Game Department in a fisheries report on Lake Tahoe that dissolved oxygen concentrations greater than 9 ppm exist down to depths of 500 feet.

Tables 13 and 14 show additional water quality data. These data were obtained by the California State Health Department in connection with a monitoring program to determine the possible pollutional effects on the lake and its tributaries of 1) the North Tahoe Public Utility District, Tahoe City Public Utility District (both in Table 13), and 2) the South Tahoe Public Utility District (Table 14) treatment plants.

TABLE 8

CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT TAHOE VISTA 1/

CONSTITUENTS	1951 Avg.	1951 Min.	1951 Max.	1952 Avg.	1952 Min.	1952 Max.	1953 Avg.	1953 Min.	1953 Max.
Turbidity in PPM	17	0	25	5	1.8	8	0.8	0	2
pH	7.7	7.5	8.1	7.7	7.3	8.1	7.5	7.2	7.8
Total Dissolved Solids in PPM	67			62	62	62	67	65	68
Specific Conductance (Micromhos at 25°C)	104	99	108	96.8	93.8	100	93.9	86.8	97.2
Total Hardness as $CaCO_3$ in PPM	34	33	36	33	32	34	34	32	35
Calcium in PPM	9.2			9.5	9.4	9.6	9.5	9.1	10
Magnesium in PPM	2.4			2.4	2.3	2.4	2.4	1.7	3.0
Sodium in PPM	6.8	6.0	7.6	6.4	6.0	6.7	6.5	5.8	8.2
Carbonate in PPM	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	51	37	57	55	53	56	54	52	56
Sulfate in PPM	3.9			2.3	2.2	2.3	4.2	1.9	6.5
Chloride in PPM	2.6	0	6	2.1	1.2	4	2.3	1.5	3.0
Nitrate in PPM	0			0.1	0	0.1	0.1	0.0	0.2

1/ Samples collected by State of California Department of Water Resources with Analyses by U.S.G.S. on a cooperative basis.

TABLE 8 (Continued)

CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT TAHOE VISTA 1/

CONSTITUENTS	1954 Avg.	1954 Min.	1954 Max.	1955 Avg.	1955 Min.	1955 Max.	1956 Avg.	1956 Min.	1956 Max.
Turbidity in PPM	0.6	0.2	1	1	0.2	6	0.9	0.1	2
pH	7.6	7.3	7.9	7.3	6.8	7.7	7.5	6.8	7.9
Total Dissolved Solids in PPM	63	62	63.8	64	63	65	64	63	65
Specific Conductance (Microohos at 25°C)	95.5	93.7	97.3	95.0	92.8	97.0	92.6	91.7	93.7
Total Hardness as $CaCO_3$ in PPM	33	32	34	34	32	37	33	32	35
Calcium in PPM	9.7	8.9	10	9.1	8.6	9.3	9.4	8.8	10
Magnesium in PPM	2.2	1.9	2.5	2.7	2.2	3.4	2.4	1.8	3.2
Sodium in PPM	6.2	5.7	6.5	6.1	5.9	6.8	6.0	5.9	6.3
Carbonate in PPM	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	55	53	56	56	54	58	56	56	57
Sulfate in PPM	2.8	2.2	4.0	1.9	1.8	2.0	1.0	0.0	2.0
Chloride in PPM	2.1	1.2	2.8	1.7	0.8	2.2	1.3	0.2	2.3
Nitrate in PPM	0.1	0.1	0.1	0.2	0.2	0.2	0.0	0.0	0.0

1/ Samples collected by State of California Department of Water Resources with Analyses by U.S.G.S. on a cooperative basis.

TABLE 8 (Continued)
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE
AT TAHOE VISTA 1/

CONSTITUENTS	1957 Avg.	1957 Min.	1957 Max.	1958 Avg.	1958 Min.	1958 Max.	1959 Avg.	1959 Min.	1959 Max.	1960 Avg.	1960 Min.	1960 Max.
Turbidity in PPM	2	0.3	7.5	3	0	5	2	0.3	10	5	1	15
pH	7.6	7.5	7.9	7.8	7.5	8.4	7.8	7.4	8.0	7.6	7.2	8.0
Total Dissolved Solids in PPM	66	62	69	64	63	64	64	62	65	63	61	64
Specific Conductance (Micromhos at 25°C)	94.5	91.2	104	94.8	91.2	105	94.5	91.6	99.3	94.2	91.0	100
Total Hardness as $CaCO_3$ in PPM	35	32	41	34	31	39	34	32	39	34	31	37
Calcium in PPM	9.7	8.8	11	9.0	8.8	9.2	10.2	9.4	11	9.6	9.2	10
Magnesium in PPM	2.2	1.8	2.9	2.3	2.2	2.4	1.9	1.3	2.4	2.2	2.2	2.2
Sodium in PPM	6.1	5.5	6.6	5.9	5.3	6.4	6.4	5.2	8.0	5.9	5.0	6.5
Carbonate in PPM	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	52	50	55	51	48	58	51	39	56	53	49	56
Sulfate in PPM	2.4	1.9	2.9	3.8	3.8	3.8	2.5	2.0	2.9	0.9	0.8	1.0
Chloride in PPM	2.5	1.8	3.0	2.7	1.0	3.8	2.9	1.5	4.8	2.3	1.5	4.0
Nitrate in PPM	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0

1/ Samples collected by State of California Department of Water Resources with Analyses by U.S.G.S. on a cooperative basis.

TABLE 9

CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT TAHOE CITY 1/

CONSTITUENTS	1951 Ave.	1951 Min.	1951 Max.	1952 Ave.	1952 Min.	1952 Max.	1953 Ave.	1953 Min.	1953 Max.
Turbidity in PPM	15	0	25	4	0.5	10	0.8	0	2
pH	7.9	7.5	8.3	7.7	7.3	8.1	7.5	7.1	7.7
Total Dissolved Solids in PPM	64	63	64	62	62	62	64	64	64
Specific Conductance (Micromhos at 25°C)	100	94	107	97.2	89.2	108	92.4	87.5	95.6
Total Hardness as $CaCO_3$ in PPM	33	32	35	33	32	34	33	32	34
Calcium in PPM	9.4	9.2	9.6	9.0	8.6	9.4	9.2	8.8	9.7
Magnesium in PPM	2.6	2.2	2.9	2.5	2.3	2.7	2.4	1.9	2.9
Sodium in PPM	6.4	5.1	7.5	6.5	6.0	6.9	5.8	1.4	8.2
Carbonate in PPM	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	53	45	55	55	54	56	53	52	55
Sulfate in PPM	2.1	2.0	2.2	2.1	2.1	2.1	3.3	2.6	3.9
Chloride in PPM	2.0	0	6	2.0	1	3	2.0	0.5	3
Nitrate in PPM	0.12	0.06	0.17	0.1	0	0.2	0.1	0	0.2

1/ Samples collected by State of California Department of Water Resources with analyses by U.S.G.S. on a cooperative basis.

TABLE 9 (Continued)
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT TAHOE CITY 1/

CONSTITUENTS	1954 Avg.	1954 Min.	1954 Max.	1955 Avg.	1955 Min.	1955 Max.	1956 Avg.	1956 Min.	1956 Max.
Turbidity in PPM	2	0	8	2	0.0	6	0.5	0.2	1
pH	7.5	7.2	7.7	7.3	6.8	7.8	7.3	6.8	7.7
Total Dissolved Solids in PPM	63	61	63.8	63	62	64	80	64	95
Specific Conductance (Micromhos at 25°C)	95.8	93.6	102	94.0	92.7	95.3	95.2	91.4	112
Total Hardness as $CaCO_3$ in PPM	33	32	35	33	31	34	34	32	36
Calcium in PPM	9.5	9.0	10	9.5	8.3	11	9.5	8.9	10
Magnesium in PPM	2.3	2.0	2.6	2.2	1.6	2.7	2.5	1.8	2.9
Sodium in PPM	6.1	5.6	6.7	5.9	5.6	6.0	6.5	5.6	9.8
Carbonate in PPM	0	0	0	0	0	0	1	0	7
Bicarbonate in PPM	54	51	56	54	50	56	56	55	56
Sulfate in PPM	2.4	2.1	2.6	2.1	0.0	4.1	1.0	0.0	2.0
Chloride in PPM	2.1	1.2	3.0	1.4	0.1	2.5	1.4	0.7	1.8
Nitrate in PPM	0.2	0.1	0.2	0.4	0.2	0.5	0.0	0.0	0.0

1/ Samples collected by State of California Department of Water Resources with analyses by U.S.G.C. on a cooperative basis.

TABLE 9 (Continued)
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT TAHOE CITY 1/

CONSTITUENTS	1957 Avg.	1957 Min.	1957 Max.	1958 Avg.	1958 Min.	1958 Max.	1959 Avg.	1959 Min.	1959 Max.	1960 Avg.	1960 Min.	1960 Max.
Turbidity in PPM	1	0.6	4.2	2	0.2	5	2	0.2	10	8	1	30
pH	7.7	7.5	7.9	7.7	7.5	7.8	7.7	7.5	8.0	7.6	7.1	8.0
Total Dissolved Solids in PPM	64	62	66	65	63	67	63	62	64	61	60	62
Specific Conductance (Micromhos at 25°C)	93.1	86.8	96	93.6	91.6	95.2	93.6	90.9	95.7	96.4	92.6	124
Total Hardness as $CaCO_3$ in PPM	35	31	43	34	30	38	34	32	38	36	32	52
Calcium in PPM	9.4	9.1	10	9.2	9.2	9.2	11.1	9.2	13	8.8	8.0	9.6
Magnesium in PPM	2.4	2.1	2.7	2.6	1.7	3.4	1.3	0.4	2.2	2.6	1.9	3.3
Sodium in PPM	6.2	5.5	6.6	6.0	5.4	6.3	6.3	5.5	6.9	5.9	5.1	6.8
Carbonate in PPM	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	52	50	56	50	46	52	50	44	52	53	46	67
Sulfate in PPM	1.2	0.0	2.3	4.8	3.8	5.8	3.9	2.0	4.8	1.1	1.0	1.2
Chloride in PPM	2.4	1.5	4.0	2.8	1.5	3.5	2.8	1.8	4.8	2.0	0.4	4.5
Nitrate in PPM	0.3	0.0	0.5	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1

1/ Samples collected by State of California Department of Water Resources with analyses by U.S.G.S. on a cooperative basis.

TABLE 10
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT BLIGH 1/

CONSTITUENTS	1951 Avg.	1951 Min.	1951 Max.	1952 Avg.	1952 Min.	1952 Max.	1953 Avg.	1953 Min.	1953 Max.
Turbidity in PPM	14	0	25	9	1.3	20	1	0	2
pH	7.6	7.4	7.9	7.7	7.5	8.1	7.4	6.8	7.7
Total Dissolved Solids in PPM	76	63	86	60	59	60	61	60	62
Specific Conductance (Micromhos at 25°C)	99	93	105	94.7	92.0	103	90.7	84.0	96.2
Total Hardness as $CaCO_3$ in PPM	34	32	38	33	30	38	33	31	36
Calcium in PPM	9.1	9.0	9.2	8.9	8.8	9.0	9.4	8.6	10
Magnesium in PPM	2.7	2.4	2.9	2.4	2.3	2.4	2.3	1.6	3.2
Sodium in PPM	6.4	5.6	7.5	6.3	5.6	6.9	6.9	6.0	9.2
Carbonate in PPM	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	52	40	56	53	51	56	52	42	55
Sulfate in PPM	2.7	2.4	3.0	2.2	2.1	2.3	2.1	2.0	2.2
Chloride in PPM	2.2	0	6	2.3	1.0	4	2.4	1.8	3.5
Nitrates in PPM	0.3	0	0.5	0.2	0.0	0.3	0.1	0.0	0.1

1/ Sample collected by State of California Department of Water Resources with analyses by U.S.G.S. on a cooperative basis.

TABLE 10 (Continued)
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT BIJOU 1/

CONSTITUENTS	1954 Avg.	1954 Min.	1954 Max.	1955 Avg.	1955 Min.	1955 Max.	1956 Avg.	1956 Min.	1956 Max.
Turbidity in PPM	1	0	5	5	0.3	20	0.4	0.2	0.6
pH	7.7	7.4	8.0	7.4	7.2	7.5	7.3	6.8	7.5
Total Dissolved Solids in PPM	63	60	66	63	62	63	63	62	63
Specific Conductance (Micromhos at 25°C)	93.8	88.4	97.8	96.2	91.0	108	90.2	84.6	95.1
Total Hardness as $CaCO_3$ in PPM	33	31	34	33	30	37	32	31	34
Calcium in PPM	9.4	8.8	9.7	9.4	8.9	9.8	9.0	8.4	9.6
Magnesium in PPM	2.3	2.0	2.5	2.2	1.6	3.2	2.2	2.0	2.6
Sodium in PPM	6.1	5.4	6.4	6.1	5.8	6.7	5.9	5.6	6.1
Carbonate in PPM	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	54	50	56	54	53	57	54	52	57
Sulfate in PPM	2.3	2.2	2.5	1.1	0.0	2.1	0.5	0.0	1.0
Chlorides in PPM	1.8	1.0	3.0	1.5	0.4	3.2	1.6	1.0	2.4
Nitrates in PPM	0.1	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.0

1/ Sample collected by State of California Department of Water Resources with analyses by U.S.G.S. on a cooperative basis.

TABLE 10 (Continued)
CHEMICAL ANALYSES OF SURFACE WATERS OF LAKE TAHOE AT BIJOU 1/

CONSTITUENTS	1957 Avg.	1957 Min.	1957 Max.	1958 Avg.	1958 Min.	1958 Max.	1959 Avg.	1959 Min.	1959 Max.	1960 Avg.	1960 Min.	1960 Max.
Turbidity in PPM	0.9	0.4	2	3	0.4	10	3	0.3	15	4	1	15
pH	7.6	7.3	7.9	7.6	7.3	7.9	7.7	7.2	8.1	7.5	6.9	7.9
Total Dissolved Solids in PPM	63	58	68	65	62	68	59	54	63	59	57	61
Specific Conductance (Micromhos at 25°C)	88.2	67.7	97	92.2	87.1	96.1	91.3	75.4	100	93.1	86.8	100
Total Hardness as $CaCO_3$ in PPM	34	21	40	33	30	36	33	27	37	34	30	40
Calcium in PPM	8.7	7.6	10	8.8	8.4	9.2	8.9	8.4	9.4	8.2	8.0	8.3
Magnesium in PPM	1.6	0.6	2.4	2.7	2.2	3.2	2.0	1.7	2.3	2.7	2.4	2.9
Sodium in PPM	5.9	4.1	6.7	5.8	5.3	6.2	6.3	5.2	7.2	6.0	5.1	6.9
Carbonate in PPM	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate in PPM	49	36	52	49	48	50	48	42	52	51	44	57
Sulfate in PPM	1.0	0.0	1.9	4.3	3.8	4.8	2.5	2.0	2.9	1.9	0.8	3.0
Chloride in PPM	2.0	0.4	3.0	2.7	1.0	3.8	2.6	1.8	4.1	2.1	1.2	3.5
Nitrates in PPM	0.1	0.0	0.2	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2

1/ Sample collected by State of California Department of Water Resources with analyses by U.S.G.S. on a cooperative basis.

TABLE 11

UNITED STATES
PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS 1/

	Limiting Values PPM
Physical Characteristics	
Turbidity	5 units
Color	15 units
Odor	3 units
Chemical Characteristics	
Total Dissolved Solids	500 R
Inorganic Substances	
Arsenic (As)	0.01 R, 0.05 M
Barium	1.0 M
Cadmium	0.01 M
Chloride	250 R
Chromium (Hexavalent)	0.5 M
Copper	1.0 R
Fluoride	0.7 - 1.7 R 2/
Iron	0.3 R
Lead	0.05 M
Manganese	0.05 R
Nitrates (NO_3)	45 R
Selenium	0.01 M
Silver	0.05 R
Sulfates (SO_4)	250 R
Zinc	5 R
Organic Substances	
Alkyl Benzene Sulfonate (ABS)	0.5 R
Chloroform Carbon Extract (CCE)	0.2 R
Cyanides	0.01 R
Phenols	0.001 R

1/ U. S. Public Health Drinking Water Standards as published in the Federal Register on July 27, 1961.

2/ The recommended limit depends on the average maximum daily air temperature.

R - Recommended limits used to indicate levels at which the water is made objectionable to an appreciable number of people.

M - Mandatory limit, a limit used to protect the health of water users from toxic substances.

TABLE 12

BACTERIOLOGICAL AND DISSOLVED OXYGEN ANALYSES OF SURFACE WATERS OF LAKE TAHOE 1/

Sampling Location	Year	Temp. In °F			Dissolved Oxygen				Coliform MPN/ML.	
		Avg.	Min.	Max.	Avg. in PPM	Min. in PPM	Max. in PPM	% Sat. 2/	Median	Range
Tahoe Vista	1951	64	55	68	8.0	7.8	8.3	83	9.5	<0.045-240.
	1952	58	54	65	8.1	7.0	9.5	79	0.44	<0.045-62.
	1953	57	44	70	8.8	7.9	10.0	85	0.045	<0.045-0.62
	1954	57	50	68	8.8	7.7	10.1	85	0.045	<0.045-2.3
	1955	58	43	69	8.9	8.0	10.0	86	0.22	<0.045-130.
	1956	57	45	67	8.6	7.9	10.0	83	0.34	<0.045-62.
	1957	56	47	67	8.7	7.7	10.0	83	0.06	<0.045-2.3
	1958	61	50	72	8.3	6.4	10.1	83	0.06	<0.045-230.
	1959	55	44	68	8.9	7.9	10.0	84	0.07	<0.045-23.
	1960	54	39	73	9.1	7.4	10.6	85	0.06	<0.045-0.62
Tahoe City	1951	57	45	66	8.6	8.2	9.6	83	0.49	<0.045-50.
	1952	57	50	63	8.3	7.1	9.3	80	42.5	<0.045-230.
	1953	55	45	70	9.2	8.3	10.2	87	0.06	0.02-13.
	1954	55	47	63	8.9	8.1	9.7	84	0.62	<0.045-62.
	1955	58	40	68	9.0	8.1	10.0	87	0.14	<0.045-6.2
	1956	58	48	67	8.7	7.5	10.0	84	0.42	<0.045-23.
	1957	55	44	66	8.9	7.9	9.8	84	0.23	<0.045-2.3
	1958	59	47	72	8.3	7.2	10.0	81	0.23	<0.045-2400
	1959	56	46	65	8.7	7.5	9.7	83	0.23	<0.045-230.
	1960	54	33	70	8.9	8.0	10.5	83	0.23	<0.045-6.2

TABLE 12 (Cont'd)

BACTERIOLOGICAL AND DISSOLVED OXYGEN ANALYSES OF SURFACE WATERS OF LAKE TAHOE 1/

Sampling Location	Year	Temp. In °F			Dissolved Oxygen				Coliform MPN/ML.	
		Avg.	Min.	Max.	Avg. in PPM	Min. in PPM	Max. in PPM	% Sat. 2/	Median	Range
Bijou	1951	59	50	66	8.1	7.2	9.4	79	0.06	<0.045-23.
	1952	60	56	63	8.4	7.2	9.6	83	0.62	0.004-62
	1953	54	42	68	9.5	8.4	12.2	89	0.045	<0.045-2.3
	1954	57	48	67	8.6	7.5	9.6	83	0.045	<0.045-1.3
	1955	57	34	66	8.5	7.3	11.4	82	0.06	<0.045-6.2
	1956	57	46	67	8.4	7.4	9.9	81	0.42	0.06-620.
	1957	54	43	64	8.7	7.4	9.7	81	0.42	<0.045-500.
	1958	59	47	74	8.3	7.2	10.0	81	0.5	<0.045-1000.
	1959	55	44	66	8.5	7.6	9.9	80	0.045	<0.045-23.
	1960	53	32	74	8.7	7.2	9.9	80	0.06	<0.045-130.

1/ Samples collected by State of California Department of Water Resources with analyses by State of California Department of Public Health and by U.S.G.S. on a cooperative basis.

2/ % Saturation of Dissolved Oxygen was computed on a basis of the average dissolved oxygen divided by the saturation dissolved oxygen as determined by the average temperature. These saturation dissolved oxygen values were directly determined from the "Solubility of Oxygen in Fresh Water" table found on page 147 of the text entitled "Stream Sanitation" by Earle B. Phelps, copyrighted in 1944 and published by John Wiley and Sons, Inc., of New York as a second edition.

TABLE 13

ANALYSES TO DETECT PRESENCE OF SEWAGE IN SURFACE WATERS IN THE NORTH TAHOE AREA 1/

Sampling Location	Date Sampled	Coliforms MPN/100 ml 2/	Chlorides (Cl^-) in PPM	Synthetic Detergent in PPM-ABS	Phosphates (PO_4) in PPM	Boron in PPM
Brockway Pier*	12-7-60	<4.5-<4.5	3.0	0.00	0.20	0.1
Barnett Pier*	11-2-60	<4.5-<4.5	2.3	0.05	0.07	
	12-7-60	<4.5- 15.	4.0	0.01	0.13	0.2
Public Beach Pier*	12-7-60	<4.5-<4.5	5.0	0.01	0.21	0.1
Sedine Street Beach*	11-2-60	4.6- 23.	2.1	0.07	0.08	
	12-7-60	<4.5- 23.	3.0	0.01	0.62	0.2
Griff Creek	11-2-60	1,300.- 24,000.	1.2	0.10	0.05	
	12-7-60	23,000.- 50,000.	3.0	0.02	0.28	0.1
Moon Beach*	11-2-60	210.-500.	2.1	0.04	0.05	
	12-7-60	12.-13.	3.0	0.01	0.29	0.0
Dry Creek	12-7-60	2,300.- 6,200.	15.0	0.05	0.80	0.0
Lake Avenue Beach*	12-7-60	<4.5-9.4	2.0	0.01	0.29	0.0
Sportsmen Pier*	11-2-60	<4.5-<4.5	1.5	0.04	0.07	
	12-7-60	6.-6.	3.0	0.00	0.28	0.4
Tahoe City, Pier #1	11-2-60	6.-23.	2.5	0.06	0.08	
Lower Truckee River	11-2-60	6.-230.	2.1	0.03	0.07	
	12-7-60	4.6-6.	3.0	0.01	0.56	0.0

* Sampling locations constitute actual lake sampling sites.

1/ Monitoring program of surface waters tributary to Lake Tahoe and the surface waters of Lake Tahoe which are capable of receiving sewage from the operation of the North Tahoe Public Utility District, by the State of California Department of Public Health.

2/ Coliform results expressed in this table represent duplicate samples as collected by the State of California Department of Public Health.

TABLE 14

ANALYSES TO DETECT PRESENCE OF SEWAGE IN SURFACE WATERS IN THE SOUTH TAHOE AREA [1]

Sampling Location	Date Sampled	Coliform [2] MPN/ML	Chlorides (Cl^-) in PPM	Synthetic Detergent in PPM ABS	Phosphates (PO_4) in PPM	Nitrites (NO_2) in PPM	Nitrates (NO_3) in PPM	Ammonium (NH_3) in PPM	Organic Nitrogen in PPM	Boron in PPM
Heavenly Valley	9-22-59	620.								
Creek Above	4-7-60	<4,5-230.	3.4	0.04	0.12	<0.001	<0.12	0.9	0.03	
South Tahoe	5-26-60	620.-2,300	2.0	0.06	0.0	0.0	0.08	0.0	0.07	
Public Utility	7-13-60	1,300-6,200	21.0*	0.004	0.072	0.003	0.2	0.002	0.38	
District Sewage	8-30-60	2,300-6,200	4.2	<0.001	0.1	0.00	0.12	0.03	0.3	
Treatment Plant	12-6-60	620.-620.	12.0	0.01	0.15					0.0
South Tahoe	9-2-59	5,000								
Public Utility	9-22-59	230.								
District Sewage	3-1-60	620.-6,200	34.0	1.04	1.4	0.01	0.2	0.02	0.06	
Treatment Plant	4-7-60	<4,5-200.	32.0	0.89	0.08	<0.001	0.31	0.17	0.52	
Seepage Drain	5-26-60	1,300.-23,000.	32.0	0.99	0.0	0.0	0.10	0.0	0.14	
	7-13-60	620.-620.	32.0	0.012	0.04	0.0	0.02	0.02	0.22	
	8-30-60	200.-2,300.	32.0	0.72	0.1	0.0	0.1	0.04	0.2	
Heavenly Valley	7-31-59	1,300.								
Creek Below	9-2-59	62.								
South Tahoe	3-1-60	2,300.-2,300.	22	0.53	0.8	0.01	0.15	0.01	0.03	
Public Utility	4-7-60	13.-23.	6.0	0.20	0.12	0.0	<0.12	0.01	0.39	
District Sewage	5-26-60	620.-6,200.	1.0	0.06	0.0	0.0	0.13	0.0	0.08	
Treatment Plant	7-13-60	230.-2,300.	19.6	0.71	0.054	0.001	0.0	0.05	0.13	
	8-30-60	500.-2,250	25.6	0.96	0.1	0.005	0.17	0.12	0.24	
	12-6-60	210.-230.	30.0	0.33	0.16					0.0

TABLE 14 (Continued)

ANALYSES TO DETECT PRESENCE OF SEWAGE IN SURFACE WATERS IN THE SOUTH TAHOE AREA 1/

Sampling Location	Date Sampled	Coliform 2/ MPN/ML	Chlorides (Cl^-) in PPM	Synthetic Detergent in PPM ABS	Phosphates (PO_4) in PPM	Nitrites (NO_2) in PPM	Nitrates (NO_3) in PPM	Ammonium (NH_3) in PPM	Organic Nitrogen in PPM	Boron in PPM
Trout Creek Above Heavenly Valley Creek	7-28-59		1.2				0.5			
	9-2-59	2,300.								
	9-22-59	5,000.								
	4-7-60	230.-2,300.								
	5-21-60	500.-21,000.								
	7-13-60	60.-620.								
	8-30-60	6,200.-23,000.								
	12-6-60	230.-500.								
Trout Creek Below Heavenly Valley Creek	7-31-51	2,300.								
	9-2-59	2,300.								
	9-22-59	1,300.								
	9-31-59	6,200.								
	4-7-60	20.-23.								
	5-26-60	620.-2300.								
	7-13-60	230.-230.								
	8-30-60	2,300.-23,000.								
	12-6-60	620.-2,300.								
Trout Creek at Highway 50 Bridge	7-31-59	1,300.								
	9-2-59	23,000.								
	4-7-60	6.-62.	0.0	0.03	0.08					
	5-26-60	230.-620.	1.0	0.05	0.0	0.0	0.05	0.01	0.08	
	7-13-60	230.-620.	0.5	0.61	0.078	0.001	0.0	0.01	0.13	
	8-30-60	620.-2,400.	1.2	<0.001	0.1	0.03	0.08	0.03	0.24	
	12-6-60	<4.5-<4.5	2.0	0.02	0.00					0.1

TABLE 14 (Continued)

ANALYSES TO DETECT PRESENCE OF SEWAGE IN SURFACE WATERS IN THE SOUTH TAHOE AREA 1/

Sampling Location	Date Sampled	Coliform MPN/ML 2/	Chlorides (Cl^-) in PPM	Synthetic Detergent in PPM ABS	Phosphates (PO_4) in PPM	Nitrites (NO_2) in PPM	Nitrates (NO_3) in PPM	Ammonium (NH_3) in PPM	Organic Nitrogen in PPM	Boron in PPM
Trout Creek - East Mouth	4-7-60	62.-230.								
Lake Tahoe at end of Connolley's Pier	4-7-60	<4.5-<4.5	1.4	0.01	0.06	<0.001	<0.12	0.01	0.0	
	5-26-60	6.-62.	2.5	0.06	0.0	0.0	0.0	0.02	0.03	
	7-13-60	<4.5-<4.5	1.5	0.94	0.02	<0.001	0.2	0.03	0.03	
	8-30-60	<4.5-<4.5	2.0	<0.001	0.1	0.0	0.005	0.05	0.15	
	12-6-60	<4.5-<4.5	2.0	0.02	0.00					0.1

* Sample was collected while part of seepage flow was diverted to a point upstream because of construction.

1/ Monitoring program of surface waters tributary to Lake Tahoe and the surface waters of Lake Tahoe which are capable of receiving sewage from the operation of the South Tahoe Public Utility District, by the State of California Department of Public Health.

2/ Hyphenated values for coliforms represent duplicate samples as collected by the State of California Department of Public Health.

APPENDIX A

ANNOTATED REFERENCES

1. "South Tahoe Sewerage Survey" - Brown and Caldwell, civil and chemical engineers, San Francisco, California, March 1959 - is an engineering study report for the South Tahoe Public Utility District on the collection, treatment and disposal of sewage in the South Tahoe area. This report includes an evaluation of present populations and trends which is developed into a projection, an evaluation of present facilities, and a consideration of the history of sewerage development, the physical geography of the area, and the characteristics of district sewage. Also considered are alternative plans for effluent disposal using present-day disposal methods. A program, including design criteria and preliminary layouts for major trunk and interceptor sewers, pumping stations, sewage treatment plants, and effluent disposal facilities, was developed. Construction is scheduled to be undertaken in four stages, the first beginning in 1959 and the fourth and last beginning about 1986. Also included were possible methods of financing this recommended development.

2. "Lake Tahoe Regional Area - Preliminary Study for a General Plan" - Wilsey and Ham, Engineers, Planners; Millbrae, California, March 1958, is a report outlining the areas of investigation necessary for development of a comprehensive, coordinated planning program for the Lake Tahoe area. The specific areas mentioned are: physical features, land use, population, economic base, circulation and transportation, public facilities and governmental ordinances. Some of the investigation has been completed in the form of an inventory. The steps leading to a general plan are formulated.

3. "Incline Village - Preliminary Report on Water Supply and Sanitary Sewerage Systems" - International Engineering Company, Incorporated, San Francisco, California, July 1960 - is an engineering study report to the Crystal Bay Development Company on the design, alternative schemes, and cost of construction of these facilities in the proposed development of the Incline Village area. The design foresees a permanent population of 26,500 people and the development of 9,000 acres located on the north shore of the lake and approximately 2 1/2 miles east of the California-Nevada Stateline.

4. "Feasibility of Formation of a General Improvement District to Serve the Tahoe Basin Area of Douglas County" - George S. Nolte, consulting civil engineers, Palo Alto, California. The outline presented places particular emphasis on the immediate and future sewage disposal problems of the area exhibiting an urbanization potential. A description of service area, land use and population projections, present sewage facilities, and the sewage characteristics are presented. Present procedure is to export sewage to the South Tahoe Public Utility District treatment facilities, at considerable cost. Based on these cost considerations, ultimate development of the area suggests district formation and construction of sewage treatment facilities. The formation of this district is outlined as well as its financial requirements and support thereof.

ANNOTATED REFERENCES

5. "Fisheries Management Report - Tahoe and Topaz Lakes" - Nevada Fish and Game Department, July 1, 1954, to June 30, 1958 - is a report which presents the results of past investigations on the ichthyological and limnological conditions existing in the Lake Tahoe Watershed. Small reports on special investigations comprise the text of the report. Specific information is contained within these special investigations on types and populations of fish, and limnological, physical and biological conditions affecting fish. This work is being supplemented by creel censuses and plantings which are being conducted with the results being published periodically.

6. "Joint Report on the Use of Water in the Lake Tahoe Watershed" - The State Engineers of Nevada and California, June 1949 - presents information on the legal restrictions in obtaining water rights in California and Nevada for the year 1949. These water rights records form the basis of determining the reported uses and amounts of water used. A correlation is also made between population values for 1948 and specific water uses. Projections were made as to estimates of future use of water and effects of increased use of water, based primarily on the continuation of past trends.

7. "Lake Tahoe Faces Water Problems" - California-Nevada Interstate Compact Commission of California, August 1958 - is a brief report mentioning problems involving water quality of the lake, adequate community planning, highway development, fire protection, maintenance of an attractive recreation atmosphere, and others. The report stresses primarily the amounts of water available, allocated, and used, as well as future water needs projections. In reporting on the Commission's action in developing a solution to these problems, a public opinion survey is mentioned which was being conducted at time of publication of this report.

8. "Water Works Program" - Brown and Caldwell - is a report to the South Tahoe Public Utility District concerning present-day problems associated with present water works in the area and a possible program of improvements. Problems primarily stressed concern the existing substandard supply and distribution systems which have arisen from the existence of eight small water companies unable economically to improve upon their respective water works. The recommended program of improvement involves the integration of these smaller systems into the South Tahoe Public Utility District based on a fourteen point proposed outline. This outline is fundamentally based on population predictions and involves considerable annexation.

9. Preliminary Report on Pollution of Interstate Waters Northwestern Lahontan Basin, USPHS, June 1952. This report presents tabulated data on sources of municipal pollution in the entire basin, which includes Lake Tahoe. The report indicates that both states seemed satisfied with the water quality in the Lake Tahoe area at that time.

There is some discussion of a potential problem with a large pleasure boat docking on the Nevada side which may on occasion discharge sewage to the lake.

10. Interstate Water Pollution Docket, Lake Tahoe, California and Nevada, USPHS, September 1957, DSES. This docket presents a review of the interstate pollution control problem and the status at that time. Specific points discussed are: sources of pollutants, water quality data with reference to water pollution indicators, and water use and quality objectives. A short discussion of regulations pertinent to water pollution is included.

The report concluded that the then existing problems were known to the states and were being investigated. Water quality was classified as safe for domestic use if chlorinated.

11. Summary Report on Quality of Interstate Waters, Lake Tahoe, Steptember 1958 (California-Nevada). This report presents data on water quality (bacteriological and chemical) with a brief mention of the then existing sewage treatment facilities. Information on water pollution legislation in both states is included, with a discussion of the actions of official agencies. Estimates of present and potential user populations are made.

12. Interoffice Status Reports by the California State Health Department.

a. "Lake Tahoe Resort Area in California - Summary of Findings from a Preliminary Sanitary Survey" by J. A. Harmon, Junior Sanitary Engineer, from September 18, 1946.

b. "Report on Sanitary Survey of Lake Tahoe" by M. E. Stewart, Assistant Sanitary Engineer, from June 26, 1946, to September 18, 1946.

c. "A Study of Sewage and Industrial Waste Disposal Practices in the Lake Tahoe-Truckee River Region of California," Code 52-6-1, prepared for Lahonton Regional Water Pollution Control Board by State Department of Public Health, Bureau of Sanitary Engineering, in 1951.

d. "Report on Water Pollution Control - Lake Tahoe Watershed" by Nevada State Department of Health, Division of Public Health Engineering - February 1953.

e. "Report on Evaluation of Existing Sewage Works and Proposed Expansion Program for the North Tahoe Public Utility District together with a Sanitary Survey of Adjacent Unsewered Areas," by State of California Department of Public Health, Bureau of Sanitary Engineering - August 1956.

ANNOTATED REFERENCES

f. "Report on Study of Present Sewage Disposal Conditions and Proposed Sewage Project for South Tahoe Public Utility District" by State of California Department of Public Health, Bureau of Sanitary Engineering - October 1955.

g. "Report on Sanitary Survey, Tahoe City, California," by L. H. Hokom, Sanitary Inspector - September 16 and 17, 1947, and October 1 and 2, 1947.

h. "Sanitary Survey of Water Systems, Lake Tahoe Area," by L. H. Hokom, Sanitary Inspector - July-August 1949.

i. "Lake Tahoe Investigation - Report on the Uses of Water in the Lake Tahoe Watershed in California - Basic Data" by State of California Department of Public Works, Division of Water Resources - June 1949.

j. "Survey of Water Supplies around Lake Tahoe Starting at California-Nevada Stateline near Brockway, thence Northerly," by H. J. Ongarth, Bureau of Sanitary Engineering - July 10-15, 1939.

k. "Sanitary Survey - Brockway Water Company," by Melvin J. Wise, Assistant Sanitary Engineer - April 1, 1954.

l. "Sanitary Survey - Pinewood Water Company," by Leonard W. Ham, Junior Sanitary Engineer - April 16, 1957.

m. "Sanitary Survey - Tahoe Sierra Water Company," by Leonard W. Ham, Junior Sanitary Engineer - April 16, 1957.

APPENDIX B

CURRENT STUDIES ON LAKE TAHOE

Water Quality and Allied Studies on Lake Tahoe Either in Progress or Anticipated

I. Development of a comprehensive regional plan for the Lake Tahoe Basin - It is anticipated that this study will be initiated in the very near future depending on the results of an application for federal urban planning assistance. This study has a bearing on water quality insofar as the conception and acceptance of a comprehensive plan for development will indicate the potential land use and population patterns that will develop and thus lead to a forecast of the probable waste disposal and pollution problems. Specifically, the proposed program is as follows:

A. Inventory, research, up-dating of all existing data to the fullest extent possible.

B. Coordination of the work of all official and unofficial agencies and groups planning for the future development of any part of the area.

C. Analysis of data; forecasts of future population, employment, land and other needs.

D. Design of preliminary Regional Plan.

E. Design of a Regional Plan.

F. Implementation of the Regional Plan.

II. Investigation of the basic productivity and limiting factors in Lake Tahoe. This study is currently in progress and is part of a three-year National Science Foundation supported investigation of three lakes in California. The principal investigator is Dr. Charles R. Goldman, a limnologist with the University of California at Davis. Dr. Goldman has completed approximately two years of his research work at the lake during which time he has made monthly measurements of the basic productivity using the Carbon^{14} technique. This work will establish a datum from which the effects of urbanization of the Basin on the lake can be measured.

III. "Lake Tahoe Fisheries Study" - State of California, El Dorado and Placer Counties. This study is aimed at developing a better fishery potential in the lake. Particular points that the study will focus on include: basic fertility and related forage fish, lack of natural reproduction of the fish, and the effects of competition and predation on trout populations. To implement these studies a stocking program is under way. This study has a probable length of 6-10 years and will need the equivalent of four full-time men in the initial stages.

CURRENT STUDIES ON LAKE TAHOE

IV. California State Department of Public Health
Water Quality Survey of
Lake Tahoe, Fallen Leaf Lake
Donner Lake, and Truckee River Areas

Preliminary Plan

A. Objective

To determine to what extent, if any, the present waste disposal practices (individual and community) affect the quality of surface and underground waters as sources of domestic water supply.

B. Dates of Extensive Field Sampling and Laboratory Analyses

June 19 - July 7, 1961 inclusive
August 21 - September 8, 1961 inclusive

C. Procedures

1. Individual Water Supplies

   a. Wells (representative number)

      (1) Data on Depth and Construction
      (2) Coliform Analyses
      (3) Detergent Analyses
      (4) Phosphate Analyses
      (5) Nitrates, Nitrite, NH_3-N

   b. Surface Waters

      (1) Data on Intakes, Location from Shore, Docks, Creeks, Sanitary Hazards, etc.
      (2) Coliform Analyses
      (3) Detergent Analyses
      (4) Phosphate Analyses
      (5) Nitrates, Nitrite, NH_3-N
      (6) Turbidity

2. Community Supplies

   a. Wells (Same Data & Analyses as for Individual Supplies)

   b. Surface Waters

APPENDIX B (Continued)

CURRENT STUDIES ON LAKE TAHOE

IV. (Continued)

Same Data and Analyses as for Individual Supplies, Plus Turbidity and Carbon Filter Sample at:

(1) Connolley's
(2) Meek's Bay
(3) Tahoe City
(4) Kings Beach
(5) Donner Lake
(6) Fallen Leaf Lake

c. Data on No. Services, Range No. People Served, Approx. Quantity Max. and Min. Daily

3. Waste Disposal

a. Individual Disposal Systems

(1) Locations, Number, Relation to Water Supply, Percolation Data, etc.
(2) Evaluate Effects, if any, on Water Quality
(3) Practices of Septic Tank Sludge Disposal

b. Community and Resort Disposal Systems

(1) General Description of Facilities
(2) Evaluate Effects, if any, on Water Quality

(a) Tahoe City
(b) Squaw Valley (2 plants)
(c) Truckee Sanitary District
(d) South Tahoe P.U.D.
(e) North Tahoe P.U.D.
(f) Brockway Resort
(g) Tahoe Tavern
(h) State Parks

c. Evaluation of Industrial Operations on Water Quality

(1) Log Pond - Blackwood Creek
(2) Gravel Washing Operations - Madden Creek

4. Surface Water Investigations

a. Areas to be Surveyed

(1) Lakes - Adjacent to Populated Areas
(2) Lakes - Adjacent to Confluences of Creeks
(3) Streams - Above, Adjacent and Below Populated Areas

APPENDIX B (Continued)

CURRENT STUDIES ON LAKE TAHOE

IV. (Continued)

b. Analyses

(1) Temperature
(2) Coliform (Emphasis on Depth Sampling in Lake)
(3) Phosphate
(4) NO_3
(5) ABS
(6) Turbidity
(7) Algae

APPENDIX C

LAND USE, PLANNING AND POPULATION DATA

1. LAKE TAHOE REGION IN EL DORADO COUNTY, CALIFORNIA - TENTATIVE AREA AND POPULATION SUMMARY ANALYSIS.

Areas:

Tahoe Watershed in El Dorado County (Land Only)	110,000 acres
Land Planned for Intensive Development	20,000 "
Land in Subdivisions Recorded or Approved by Planning Commission	10,000 "
Land in Miscellaneous Developments other than Subdivisions	2,000 "
Land Undeveloped in Intensive Development Plan	8,000 "

Subdivisions:

Subdivisions Recorded or Approved by Planning Commission	120 subdivs.
Lots Recorded or Approved by Planning Commission	25,000 lots
Recorded Assessment Parcels	15,000 prcls.
Gross Density of Subdivisions Recorded or Approved by Planning Commission	2½ lots/acre
Projected Gross Density of Undeveloped Land	2 lots/acre
Projected Ultimate Subdivision Lots	41,000 lots

Population:

Ultimate Total Nonresidential Lots	1,000 lots
Ultimate Total Multi-Dwelling Unit Lots	5,000 "
Ultimate Average Multi-Dwelling Unit Net Density	5 dw.un./lot
Ultimate Total One Fev. Unit Lots	35,000 lots
Ultimate Total Dwelling Units	60,000 "
Ultimate Gross Size of Dwelling Units	3 pers./dw.un.
Present Permanent Population	9,000 pers.
Ultimate Permanent Population (Projected in 1985)	50,000 "
Ultimate Peak Seasonal Residential Population	130,000 "
Ultimate Peak Total Residential Population	180,000 "
Ultimate Peak Transient-Tourist Population	100,000 "
Ultimate Peak Total Permanent, Seasonal and Transient Population	280,000 "

2. LAND USES AND ALLOCATIONS.

Nevada side of Lake Tahoe (Washoe, Ormsby and Douglas Counties) within the watershed portions.

There are 40,000 acres (62.5 sq. miles) of watershed land lying within the Nevada portion of Lake Tahoe in Douglas, Washoe and Ormsby Counties. 15,120 acres (23.6 sq. miles) or 37.5% of this area may be considered potentially "urban" in character in that it has an average

cross slope of less than 25% and thus may be considered topographically suitable for more "intensive" development of both a residential and commercial nature. Forest lands cover 4,418 acres (6.9 sq. miles) or 11% of this total area and Capt. Whittell's lands (the largest single landowner) include some 16,247 acres (25.4 sq. miles) or 40.5%. The remaining area, 20,500 acres or 32 sq. miles, constituting 51.5% of the total area is in general too steep or inaccessible to admit much development potential, other than perhaps an extremely low density summer residence. In summation:

37.5% is "urban" or potentially urban
11.0% is forest reserves
51.5% is marginal use lands

There are 28.5 lineal miles of shoreline (probably a bit higher due to the irregularity of the coastline) in Nevada, of which 10.6 miles (37.6%) are controlled by Whittell.

Further, more exact breakdowns of each county indicates:

Washoe County

10,195 acres of watershed area (15.9 sq. miles) or 25.9% of total
4,087 acres of "urban area" (6.4 sq. miles) or 27.0% of total
2,138 acres of forest lands (3.3 sq. miles) or 21.0% of total
2,691 acres of Whittell lands (4.2 sq. miles) or 38.0% of total
11.3 lineal miles of shoreline

Ormsby County

6,025 acres of watershed (9.4 sq. miles) or 14.9% of total
987 acres of "urban area" (1.54 sq. miles) or 6.5% of total
551 acres of forest lands (.87 sq. miles) or 9.15% of total
4,197 acres of Whittell lands (6.55 sq. miles) or 80.0% of total
4.35 lineal miles of shoreline

Douglas County

23,789 acres of watershed area (37.1 sq. miles) or 59.2% of total
10,246 acres of "urban area" (15.7 sq. miles) or 66.5% of total
1,729 acres of forest lands (2.7 sq. miles) or 7.5% of total
9,360 acres of Whittell lands (14.6 sq. miles) or 39.5% of total
12.7 lineal miles of shoreline

At the present time there are 1,475 platted lots in Washoe County, none in Ormsby County and 1,704 in Douglas County for a total of 3,179 lots in about the last eight years. In addition, individual properties (metes and bounds, parcels, etc.) total an additional 1,100 in Douglas County and about 150 in Washoe County for a total of 1,250 and a grand total lot and parcel count of about 4,430.

APPENDIX C (Continued)

LAND USE, PLANNING AND POPULATION DATA

There are now about 100 erected homes within Washoe County, 4 in Ormsby County, and about 1,300 in Douglas County for a total of 1,400 dwelling units within the Basin area. About 400 of these are occupied year-round and some 450 have been built during the last five years. Trailer courts, apartments, etc. add an estimated 250 units additional for a Nevada side total of 1,650-1,700 units at the present time.

There is now about 140 acres used for commercial purposes, mostly in the immediate vicinity of the Statelines - both at the north and south end. In addition, 3,160 acres are presently developed in residential usage, 4,418 acres of committed forest reserves and 34,534 acres of "vacant" area.

Present populations are: Washoe County - 100 permanent residents increasing to about 500 during the summer months; Ormsby County - no permanent residents but about 15 during the summer; Douglas County - 1,000 permanent residents increasing to about 6,500 during the summer. This represents a doubling in population (both winter and summer rates) for Washoe County during the last 10 years, a static condition in Ormsby County and a tripling in Douglas County.

Recapitulations:

Washoe County alone contains 4,087 acres of "urban land", 27% of the total Nevada category. Most of it is in Incline Valley - the site of INCLINE VILLAGE, which, for example, sets forth the first stage plan to cover some 4,100 acres of the more usable flatter lands within the valley floor. About 250 of these acres are now developed in a low density residential category (Incline Beach Sub. et al), 2,100 acres more are planned for immediate development as part of the Incline Village development program and 1,780 in addition are programmed for future activity. Present populations, now varying between 100 and 500 are expected to swell to an optimum figure of 18,000 (by 1967) with a maximum planned capacity of 25,000. This entire area is to be served with a domestic water system and all commercial and multiple residential uses will be completely sewered, with highly-treated effluent to be transported beyond the basin limits into Washoe Valley to the east.

Beyond Incline, there is little buildable land available. Sand Harbor, now a State Park, comprising some 156 acres (including a strip of shoreline in both directions) and a marginal slope area of about 280 acres around Marlette Reservoir are the only other possible areas of future activity. Both lie within the Whittell holdings and neither are anticipated to become developable within the near future.

Ormsby County with only 987 acres of "urban land" potential (6.5% of the total Nevada side) is also restricted in development potential. Most of this area lies in the Spooners Summit (and lake) section, also owned by Whittell. It would appear that this region is

most suitable for a commercial intersection (motel, gas, restaurant facilities) but it does not have a view of the lake. Some 10 acres of the county is now developed residentially at Skunk Harbor. It is likely that this portion of the county will stay in its present open state for some time. Present population, about 15 during the summer, could increase to about 2,000 if the forementioned commercial activity should take place.

Douglas County is the Nevada "problem area". By far the largest element, it includes 23,789 acres of watershed area (59.2% of total) with some 10,050 acres of potentially usable land - 66.5% of all such land on the Nevada side. 110 acres of this are now used commercially (Harrahs, Harveys, etc. at Stateline and a few scattered strip commercial zones), 3,000 acres are residentially occupied, mostly in the Kingsbury area, 1,730 acres are forest, and the remainder - 19,000 acres - is, for the most part, vacant. Main developments to date are in the Stateline-Kingsbury section (mostly subdivisions of 12,000 sq.ft. single family lots) a narrow shelf of homes along the lake, between the main highway (SR 28, US 50) and the lake, and a few nucleated spots (Zephyr Cove, Marla Bay, Glenbrook) etc.

Future developments will depend materially on the "Whittell lands" - what and when will they ultimately be disposed. Whittell now owns 9,360 acres or 39.5% of the lake portion of Douglas County; he also controls 4,373 acres or 41.7% of the buildable "urban" lands within that area, mostly back slopes and lands lying between the road and the watershed limit. If these lands are opened up (mainly by the construction of a planned highline freeway) these areas might well support a future population of from 10,000 to 15,000, mostly on low density, spot commercial basis. Added to a potential holding capacity of 20-25,000 in the Kingsbury-Stateline section and some 10,000 along the lakeshore, a future possible Douglas County population of from 40,000 to 50,000 is entirely likely. Present developable lands are now becoming somewhat scarce, due mainly to a reluctance of present owners (other than Whittell) to dispose of, or break up, their holdings. Unless this trend is reversed, especially in the vicinity of the Stateline, land use difficulties are bound to occur.

APPENDIX D

DATA ON PARKS, CAMPGROUNDS AND FOREST SERVICE LANDS

1. National Forests

Tahoe National Forest	7,900 acres
Toiyabe National Forest	2,600 acres
El Dorado National Forest	83,800 acres

2. Campgrounds

Total number of campsites	1,083
Average daily use (estimated)	3,750

State Parks	Acres	Campsites
D. L. Bliss	947	118
Emerald Bay	567	100
Tahoe	14	40

U. S. Forest Service

Eight Campgrounds

Fallen Leaf Lake (under construction)

County Campgrounds

El Dorado

Douglas